

Evaluation of Changes in Cardiac Function in Chronic Obstructive Pulmonary Disease Treated with Acetylcysteine by Three-Dimensional Ultrasound Spot Tracking Technique

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Wang *et al.*: Effectiveness of Utilizing Three-Dimensional Ultrasound Speckle Tracking Technology

This study aims to explore and investigate the effectiveness of utilizing three-dimensional ultrasound speckle tracking technology to evaluate the changes in cardiac function of patients with acute exacerbation of chronic obstructive pulmonary disease that underwent treatment with N-acetylcysteine. We selected 100 patients with chronic obstructive pulmonary disease as the research subjects between December 2020 and December 2022. Then divided them into two groups according to whether it is during an acute exacerbation. Control group consisted of 50 patients without acute exacerbation, while observation group included 50 patients diagnosed with acute exacerbation. The levels of lung function-related indicators, serum-related indicators and heart function-related indicators were evaluated and compared among the different groups of patients. The results showed that observation group had better lung function-related indicators than control group ($p < 0.05$). Observation group had arterial blood oxygen partial pressure, serum N-terminal pro-brain natriuretic peptide and serum brain natriuretic peptide levels than control group ($p < 0.05$). Additionally, observation group had higher heart function-related indicators than control group ($p < 0.05$). The results suggest that three-dimensional ultrasound speckle tracking technology has good clinical diagnostic value in evaluating N-acetylcysteine treatment of acute exacerbations in patients with chronic obstructive pulmonary disease. This technology can effectively reflect changes in heart function and provide guidance for the treatment plan of chronic obstructive pulmonary disease.

Key words: Three-dimensional ultrasound speckle tracking, N-acetylcysteine, chronic obstructive pulmonary disease, acute exacerbation, hypertension

Chronic Obstructive Pulmonary Disease (COPD) is a prevalent respiratory disease in clinical practice that presents with chronic progressive tracheitis-related symptoms. The condition has a long course and is difficult to cure once it develops. Late-stage COPD patients can experience significantly increased pulmonary vascular resistance, which can lead to pulmonary arterial hypertension and cause serious damage to right heart function^[1]. Clinical studies have found a close correlation between COPD and right ventricle related diseases. The two diseases have a mutual influence and restriction in physiology and pathology and the degree of heart function damage may increase with the worsening of COPD. Three-dimensional ultrasound speckle tracking imaging technology demonstrates higher objectivity in

reflecting heart function^[2], especially in cases of myocardial infarction. This technology can accurately reflect regional dominant myocardial motion disorders and provide effective information support for clinical physicians treating these diseases^[3,4]. The study included 100 COPD patients from December 2020 to December 2022. Then divided them into two groups whether it is during an acute exacerbation. Control group consisted of 50 patients without acute exacerbation, while observation group included 50 patients diagnosed with acute exacerbation. All patients in this study met the diagnosis and treatment standards for COPD outlined in China's COPD Diagnosis and Treatment Guidelines established in 2007. Patients were free of other chronic diseases, such as hyperglycemia, diabetes

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and cardiovascular diseases, except for COPD. Patients were 20 y or older and had a course of 2 y or more. Clinical medical history data was collected by nurses and patients in different groups were aware of the study and its contents. Before receiving treatment, all COPD patients underwent a three-dimensional ultrasound speckle tracking technology examination. Patients with serious kidney or liver organ injury were not included in the study scope^[5]. In acetylcysteine treatment method study, all COPD patients underwent N-acetylcysteine treatment. Clinicians evaluated the severity of COPD in patients and then prescribed medication. N-acetylcysteine was taken orally 2-3 times daily, with 600 mg dissolved in warm water per dose. All patients received continuous treatment for 2 mo while carefully monitoring for any significant adverse reactions. If any adverse reactions occurred, medication was immediately discontinued and patients received follow-up treatment at the hospital^[6]. In three-dimensional ultrasound speckle tracking technology, all COPD patients underwent three-dimensional ultrasound speckle tracking examination after admission. The patients as well as technicians underwent the examination after understanding the content and items of this study. Nurses provided explanations on the three-dimensional ultrasound speckle tracking examination process and precautions to COPD patients and their families to reduce their concerns about the technique. In this study, a GE color Doppler ultrasound diagnostic instrument was used as the examination instrument. All data were collected by two clinicians who had extensive clinical examination experience. During the examination, attention was paid to setting the frequency parameter of the probe between 4 MHz and 6 MHz. In chest two-dimensional mode, medical personnel collected routine parameters of body atrium, ventricle and ventricular septum size checked for heart valve regurgitation to confirm whether the patient's heart valve had reflux. Left ventricular end-diastolic volume and left ventricular ejection fraction were measured using the biplane Simpson method with left ventricle as the measurement focus and relevant data were calculated. After obtaining the necessary data, the ultrasound diagnostic instrument was switched to the three-dimensional scan mode. In the three-dimensional scan mode, the V5 matrix probe was

replaced and the parameters were adjusted according to the three-dimensional mode before scan detection began with the harmonic turned on, and the ultrasound diagnostic instrument was switched to the optimization mode. During the process, attention was paid to observe whether the three-dimensional image remained in high definition^[7]. Healthcare professionals select the apical four-chamber view of the patient as the observation plane with a frame rate parameter set at a frequency of 24 or greater frames per second. Additionally, nurses must instruct patients with COPD to maintain breath-hold after expiration. During this breath-holding period, the 4-dimensional scanning mode is activated to acquire three-dimensional dynamic images of four consecutive cardiac cycles. The acquired image data is saved and the ultrasound scanner is switched to offline mode. Next, the three-dimensional speckle tracking analysis software corresponding to the ultrasound scanner is used to automatically delineate the inner and outer curves of the left ventricle. If the automatic delineation is unsatisfactory, manual delineation is combined to improve the quality and precision of the delineation. During the computational process, the curve of the endocardial edge is adjusted and the width of the region of interest is adjusted between three planes, ensuring that the distance is consistent with the thickness of the ventricular wall. Additionally, the echo spots in the image must remain within the myocardial range. Only after meeting all the above requirements, can the software be used to calculate the evaluation indicators of cardiac function changes using the three-dimensional speckle tracking technique. Healthcare professionals evaluate the lung function of COPD patients and calculate relevant assessment indicators. Clinical indicators of lung function include the Forced Vital Capacity (FVC) levels, Percentage of Forced Expiratory Volume (FEV1 %) predicted in 1 s and Carbon Monoxide Diffusion Capacity (DLCO). Differences in data values between patients with and without acute exacerbation are compared^[8]. Doctors use a combination of ultrasound examinations and serum testing to analyze and evaluate various serum-related indicators. These indicators include the levels of arterial oxygen pressure index, serum N-Terminal pro-Brain Natriuretic Peptide (NT-proBNP) index and B-type BNP index.

Furthermore, doctors compare the gathered data values of patients belonging to different groups^[9]. Healthcare workers use ultrasound detectors to assess patient's heart function related indicators, such as the level of Left Ventricular Myocardial (LVM), LVM Index (LVMI) and Left Ventricular End-Diastolic Volume (LVEDV). These indicators are evaluated in conjunction with clinical heart function diagnosis and evaluation criteria^[10]. In this study, statistical software was utilized to analyze the data, and a significance level of $p < 0.05$ was adopted to indicate the presence of differences. Results indicated that observed group had remarkably better pulmonary function related indicators levels than control group ($p < 0.05$), as shown in Table 1. The results showed that observation group had significantly better arterial oxygen pressure, serum NT-proBNP level and serum BNP level than control group ($p < 0.05$), as shown in Table 2. The results indicated that observation group had higher cardiac function related indicators level than control group ($p < 0.05$), as shown in Table 3. Clinical scholars have stated in their research that the right ventricle is a significant factor that affects the occurrence of

cardiovascular diseases, such as coronary heart disease, heart failure and as an independent prognostic factor for the onset of pulmonary hypertension. Therefore, it is essential for clinical practitioners to evaluate the right ventricular structure and function through cardiac function testing to accurately diagnose and treat COPD patients^[11]. Unfortunately, due to the complexity of the geometric structure of the right ventricle, traditional cardiac diagnostic tools, such as electrocardiography and ultrasound may encounter difficulties in evaluating the function and morphology of the right ventricle. This shortage of available information may lead to an inadequate understanding and may hinder the clinical experience of practitioners, leading to difficulties in formulating an effective treatment plan. The results indicate that observation group had superior levels of lung-function related indicators to control group. COPD can cause significant damage to heart function after its onset, which can lead to regional myocardial stage motion disorders and potentially acute myocardial infarction. As such, it is essential to implement appropriate clinical examination methods to understand changes in

TABLE 1: COMPARISON OF PULMONARY FUNCTION IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE BETWEEN BOTH GROUPS

Group	Cases	FVC (L)	FEV1 (%)	DLCO (mmHg)
Control	50	3.72±1.10	58.32±10.90	29.80±3.24
Observation	50	3.12±1.28	51.25±12.21	21.13±4.15
t		2.899	3.224	2.675
p		<0.05	<0.05	<0.05

TABLE 2: COMPARISON OF SERUM RELATED INDICATORS IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE BETWEEN BOTH GROUPS

Group	Cases	Arterial oxygen pressure (mmHg)	NT-proBNP (pg/ml)	BNP (pmol/l)
Control	50	82.31±17.32	115.64±30.39	22.31±3.14
Observation	50	70.28±19.15	232.10±34.52	16.75±2.98
t		2.193	2.443	3.243
p		<0.05	<0.05	<0.05

TABLE 3: COMPARISON OF CARDIAC FUNCTION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE BETWEEN BOTH GROUPS

Group	Cases	LVM (g)	LVMI (g/m ²)	LVEDV (ml)
Control	50	176.28±37.43	130.90±28.34	107.32±21.32
Observation	50	181.32±29.89	139.87±30.19	101.27±23.14
t		3.294	2.889	2.455
p		<0.05	<0.05	<0.05

heart function in COPD patients^[12].

Observation group exhibited better arterial oxygen partial pressure values, serum NT-proBNP and BNP levels than control group. While conventional ultrasound techniques are effective in determining the size of the heart and its movement coordination, they do not provide enough quantitative data on the dynamic nature of speckle echoes and myocardial movements. However, three-dimensional ultrasound speckle tracking technology offers a more objective and comprehensive evaluation of heart contraction, relaxation and myocardial movements in COPD patients. As a result, it has the potential to serve as a valuable tool for clinicians as they develop and implement treatment plans. Observation group had higher level of heart function related indicators than control group. However, the limitations of two-dimensional ultrasound detection only allowed for the collection of data on myocardial movement and left and right ventricles in a plane. The three-dimensional speckle tracking technique can overcome these limitations by providing accurate measurements of the ventricular wall motion of patient's bodies. Thus, it can provide a better understanding of the local systolic function of the ventricle and the overall motion function of the left ventricle. The three-dimensional speckle tracking imaging technique is an improved radiological technology based on the two-dimensional speckle tracking imaging technique. This technology allows for continuous, real-time calculation of cardiac volume imaging and provides a more comprehensive, three-dimensional, accurate and realistic view of the overall myocardial condition and local myocardial motion by using a three-dimensional structure. In summary, the evaluation of the use of three-dimensional ultrasound speckle tracking technology in patients with acute exacerbation of COPD treated with N-acetylcysteine showed good clinical diagnostic value. It can effectively reflect changes in the cardiac function of patients and can be used as a helpful guide in developing treatment plans for COPD.

Conflict of interests:

The authors declared no conflict of interests.

REFERENCES

- Chen S, Jin XZ, Tao Z. The impact of enteral nutrition on the nutritional status and cardiac function of patients with chronic obstructive pulmonary disease complicated with Cor pulmonale. *Chin J Integr Tradit Western Med Intensive Crit Care* 2021;28(1):83-5.
- Huang JJ. Effect analysis of health education on patients with chronic obstructive pulmonary disease complicated with coronary heart disease and chronic heart failure. *Xinxueguanbing Fangzhi Zhishi* 2022;12(20):42-4.
- Li L, Yang Y, Sun YN. Risk factors for heart failure in patients with acute exacerbation of chronic obstructive pulmonary disease and their relationship with prognosis. *J Clin Med Pract* 2021;25(15):43-52.
- Chen DY. Diagnostic value of combined detection of two-dimensional echocardiography, BNP, 6MWT and MMRC for right heart dysfunction in patients with acute exacerbation of chronic obstructive pulmonary disease. *ImageJ Technol* 2021;33(2):15-8.
- Jiang TT. Effect analysis of early warning nursing intervention on patients with chronic obstructive pulmonary disease complicated with chronic heart failure. *Health Res* 2021(5):82-95.
- Li H. Clinical analysis of non-invasive positive pressure ventilation in the treatment of type 2 respiratory failure with acute left heart failure in patients with chronic obstructive pulmonary disease. *Women's Health Res* 2021(6):37-8.
- Ke AH, Shi SJ, Sun AH. Efficacy analysis of pulmonary rehabilitation on patients with chronic obstructive pulmonary disease complicated with heart failure. *Med Diet Health* 2022;20(6):35-7.
- Yang XQ, Wang LM, Wang ZY. Evaluation of the right ventricular function in post-myocardial infarction heart failure patients using real-time 3D echocardiography combined with 3D speckle-tracking technology. *Chin J Med* 2022;57(12):1321-5.
- Zhou CX, Chen LJ, Zhang YQ. Assessment of left ventricular function changes after Glenn operation using three-dimensional speckle tracking echocardiography. *Chin J Clin Med* 2022;29(1):30-4.
- Wang XZ, Sun LL, Wang L. Diagnostic value of real-time 3D echocardiography and two-dimensional speckle tracking technology in heart failure. *J Clin Ultrasound Med* 2021;23(10):756-60.
- Xi JY, Tang JM, Liu LY. Assessment of left ventricular function in patients with non-alcoholic fatty liver disease complicated with type 2 diabetes using three-dimensional speckle tracking echocardiography. *J Pract Hepatol* 2022;25(5):661-4.
- Wu DQ, Cui LH, Wu ZH. The application value of three-dimensional speckle tracking echocardiography in the evaluation of left ventricular systolic function in children with Kawasaki disease. *China Med Equip* 2020;17(9):90-3.

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